



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(S1) International Patent Classification⁶:
H04Q 7/30, H04B 7/26

A1

(11) International Publication Number:

WO 96/27269

(43) International Publication Date: 6 September 1996 (06.09.96)

(21) International Application Number: PCT/FI96/00112

(22) International Filing Date: 26 February 1996 (26.02.96)

(30) Priority Data:
950916 28 February 1995 (28.02.95) FI(71) Applicant (for all designated States except US): NOKIA
TELECOMMUNICATIONS OY [FI/FI]; Mäkkylän puistotie 1, FIN-02600 Espoo (FI).

(72) Inventor; and

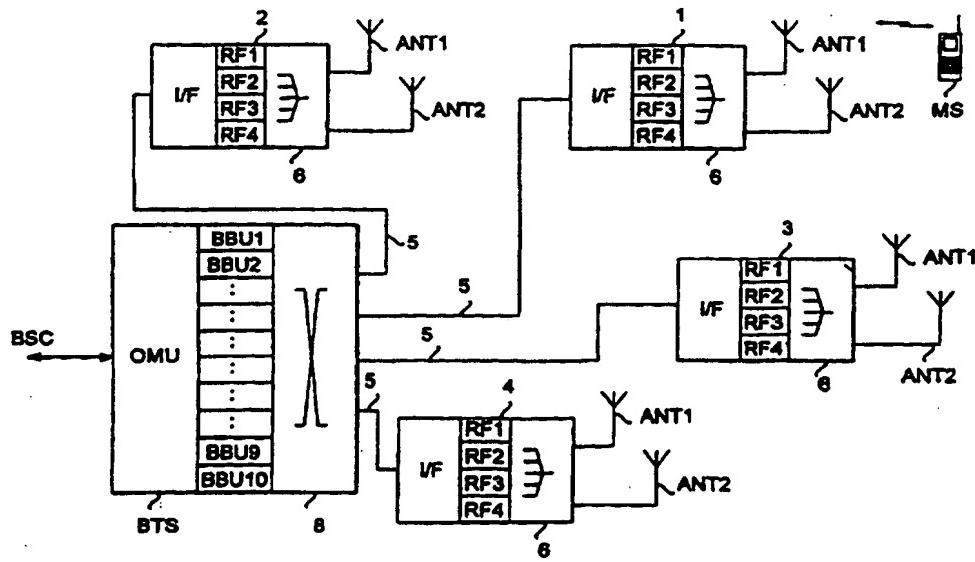
(75) Inventor/Applicant (for US only): POSTI, Harri [FI/FI];
Torikatu 33 D 8, FIN-90100 Oulu (FI).(74) Agent: OY KOLSTER AB; Iso Roobertinkatu 23, P.O. Box
148, FIN-00121 Helsinki (FI).(81) Designated States: AL, AM, AT, AU, AZ, BB, BG, BR, BY,
CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IS,
JP, KE, KG, KP, KR, KZ, LK, LR, LS, LT, LU, LV, MD,
MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD,
SE, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN,
ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent
(AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent
(AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC,
NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA,
GN, ML, MR, NE, SN, TD, TG).

Published

With international search report.

Before the expiration of the time limit for amending the
claims and to be republished in the event of the receipt of
amendments.

(54) Title: A BASE STATION OF A RADIO SYSTEM



(57) Abstract

The present invention relates to a base station of a radio system comprising means for establishing a telecommunication connection to radio units (MS) in its coverage area. In order to utilize the capacity of the base station efficiently, it comprises a central processing unit (BTS) with at least one baseband frame unit (BBU1-BBU10) for supplying baseband signals via a switching means (8) to either of at least two radio channel units (RF1-RF4), and at least two radio set units (1-4) arranged separately from one another of which at least one is arranged at a distance from the central processing unit, whereby said radio set units (RF1-RF4) are arranged into different radio set units (1-4) for transferring baseband signals to be transmitted from the frame unit (BBU1-BBU10) to a radio channel and for forwarding radio frequency signals via an antenna means (ANT1) of the radio set unit (1-4).

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AM	Armenia	GB	United Kingdom	MW	Malawi
AT	Austria	GE	Georgia	MX	Mexico
AU	Australia	GN	Guinea	NE	Niger
BB	Barbados	GR	Greece	NL	Netherlands
BE	Belgium	HU	Hungary	NO	Norway
BF	Burkina Faso	IE	Ireland	NZ	New Zealand
BG	Bulgaria	IT	Italy	PL	Poland
BJ	Benin	JP	Japan	PT	Portugal
BR	Brazil	KE	Kenya	RO	Romania
BY	Belarus	KG	Kyrgyzstan	RU	Russian Federation
CA	Canada	KP	Democratic People's Republic of Korea	SD	Sudan
CF	Central African Republic	KR	Republic of Korea	SE	Sweden
CG	Congo	KZ	Kazakhstan	SG	Singapore
CH	Switzerland	LJ	Liechtenstein	SI	Slovenia
CI	Côte d'Ivoire	LK	Sri Lanka	SK	Slovakia
CM	Cameroon	LR	Liberia	SN	Senegal
CN	China	LT	Lithuania	SZ	Swaziland
CS	Czechoslovakia	LU	Luxembourg	TD	Chad
CZ	Czech Republic	LV	Latvia	TG	Togo
DE	Germany	MC	Monaco	TJ	Tajikistan
DK	Denmark	MD	Republic of Moldova	TT	Trinidad and Tobago
EE	Estonia	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	UG	Uganda
FI	Finland	MN	Mongolia	US	United States of America
FR	France	MR	Mauritania	UZ	Uzbekistan
GA	Gabon			VN	Viet Nam

A base station of a radio system

The present invention relates to a base station of a radio system comprising: a central processing unit which includes control and maintenance means for controlling the base station in response to control signals transmitted from a base station controller, and at least one baseband frame unit for generating and supplying baseband signals further via a switching means alternatively to either of at least two radio channel units of the base station in response to telecommunication signals transmitted from the base station controller and for processing baseband signals transmitted from said radio channel unit and for supplying them further to the base station controller, and means for establishing a telecommunication connection with radio signals to radio units in the radio coverage area of the base station.

This invention primarily relates to variations in the capacity need of different parts of the geographical area covered by the cellular radio system. For example, in business centres considerably more traffic capacity is needed during daytime than in the evening. Correspondingly, the situation in suburban areas may be such that during daytime the capacity need is very small but in the evenings it becomes great when the residents return home from their places of work. If the capacity of the cellular radio system is dimensioned under these circumstances in accordance with the capacity need peaks, it will lead to a situation in which a considerable portion of the capacity of the system remains unused the most part of the day.

Solutions are known previously in which calls of an adjacent cell are transmitted by using an antenna

which can be temporarily directed thereto. In that case the coverage area of the adjacent cell cannot usually be completely covered.

5 Solutions are also known previously in which separate additional channel units are used by means of relay-type of switchings, that is, the capacity of the additional channel unit shifts from one sector or cell to another in such a way that its antenna connection is changed by means of relay switchings. In this case, the
10 geographical area on which capacity variation can be attained is very small as the RF signal from the antenna connection of the additional channel unit cannot be transferred very far e.g. by means of cables without the signal attenuation being significant in the
15 cable. That means that for practical reasons, the alternative transmission antennas to which the additional channel unit can be switched should situate very close to one another.

20 The object of this invention is to solve the above problem and provide a base station of a radio system in which the available traffic capacity can be transferred between different geographical areas in a simple and uncomplicated way and in which the transfer distances may be significantly longer than in prior art solutions. This object is achieved with the
25 base station of the radio system according to the invention that is characterized in that the base station comprises at least two radio set units arranged separately from one another of which at least one is arranged at a distance from the central processing unit, whereby said at least two radio channel units are arranged into different radio set units for transferring baseband signals transmitted from the frame unit to a predetermined radio channel and for
30 forwarding radio frequency signals via antenna means of
35

the radio set unit, and for transferring radio frequency signals received with the antenna means to the baseband and for supplying the baseband signals to the frame unit.

5 The invention is based on the idea that when at least two radio set units arranged at a distance from one another including radio units and antenna means are connected to a base station, the traffic capacity of the base station can be distributed to a
10 larger area than before because the frame unit in the central processing unit can be alternatively switched to either of the radio set units situated separate from one another based on momentary capacity needs. Because
15 the signals supplied by the central processing unit are not transferred to the radio frequency until at the radio set units, the transfer distances of the RF signals and the losses caused by their transfer can be minimized. Since the total equipment costs of the central processing unit and the separate radio set
20 units according to the invention are significantly lower than the total equipment costs of two separate previously known base stations, significant economic advantages are attained with the solution according to the invention in comparison with previous solutions.
25 The most significant advantages of the base station according to the invention are therefore that the capacity of the base station can be efficiently utilized all day as the capacity can be transferred where it is needed, that the areas between which the
30 capacity can be transferred can be situated significantly farther from one another than in known solutions, and that the equipment costs will be significantly lower.

35 The preferred embodiments of the base station according to the invention are apparent from the

5 appended dependent claims 2 to 7. In the following, the invention will be explained in more detail by means of one preferred embodiment with reference to the accompanying figure illustrating a block diagram of the base station according to the invention.

10 The base station shown in the figure can be a base station of the GSM system, for example. The structure and operation of the GSM system is explained e.g. in *The GSM System for Mobile Communications*, by M. Mouly & M. Pautet, Palaiseau, France, 1992, ISBN:2-9507190-0-0-7, wherefore it will not be described more closely in this context.

15 The base station in the figure differs from known base stations in that the equipment of the base station is decentralized to a large geographical area. Therefore there is only a central processing unit of a base station BTS at the actual site of the base station to which radio set units 1 to 4 are connected via data transmission channels 5. One or more radio set units 20 are advantageously integrated (not shown in the figure) into the central processing unit of the base station BTS or placed in its immediate vicinity.

25 The central processing unit of the base station BTS comprises an operating and maintenance unit OMU that attends to the communication between the base station and the base station controller BSC and controls the operation of the base station. The central processing unit BTS also comprises several baseband frame units BBU1 to BBU10 (Base Band Unit) which generate baseband modulation signals for radio set units 1 to 4, and which process the signals received and transmitted to the baseband by the radio set units 30 1 to 4 for forwarding them to the base station controller BSC. Subscriber data and control data transmitted in frame units BBU1 to BBU10 are channel 35

5 coded, interleaved and placed into TDMA frames (Time Division Multiple Access) after which they are supplied to the radio units situated in the radio set units in which they are modulated into a TDMA burst to a desired transmission baseband, that is, a radio channel. Correspondingly, the frame units BBU1 to BBU10 perform signal detection, frame release, interleaving release and channel decoding.

10 Frame units BBU1 to BBU10 are switched via a switching matrix 8 to the radio set units 1 to 4. The switching matrix 8 can switch any frame unit BBU1 to BBU10 in part (that is, specified time slots) or in whole to any radio set unit 1 to 4. The selected switching depends on the capacity need required in the 15 coverage area of each radio set unit 1 to 4.

20 Data channels 5 in the figure may comprise of an optical fibre, a copper cable or a micro wave link depending on the transfer distance and the capacity need. The transfer distance is restricted by the propagation delay allowed by said radio system which delay involves e.g. the time spent for transmitting data on the data channel 5. For example, the propagation delay allowed by the GSM system corresponds to a transfer distance of about 35 km on the radio 25 path.

30 The radio set units 1 to 4 comprise an interface unit I/F that attends to the communication between the radio set unit and the central processing unit BTS. The radio set units 1 to 4 also comprise radio channel units RF1 to RF4 that receive baseband signals transmitted from the data channel 5, transfer said signals to predetermined radio channels and forward the radio frequency signals via a combiner device 6 and an antenna ANT1. Similarly, the radio 35 channel units RF1 to RF4 receive radio frequency

signals from the reception antenna ANT2 and the combiner device 6 and transfer them to the baseband before they are transmitted via the interface unit I/F to a specified baseband unit BBU1 to BBU10 in the central processing unit BTS.

Frequency hopping can be applied in two alternative ways in the base station shown in the figure. The first possible way is that the radio channel units RF1 to RF4 in each radio set unit 1 to 4 are permanently tuned into different radio channels of their own, whereby frequency hopping will be accomplished in such a way that different time slots of a specified logical channel are transmitted alternately with different radio channel units RF1 to RF4 in accordance with a predetermined frequency hopping sequence. This may be achieved in such a way that the switching matrix 8 is arranged to switch the specified frame unit BBU1 to BBU10 alternately to different radio channel units RF1 to RF4 of the same radio set unit 1 to 4 always before transmitting a new burst, for example, whereby the radio channel of the logical channel maintained by said frame unit will also change.

Another possible way to accomplish frequency hopping is that a specified frame unit BBU1 to BBU10 constantly supplies signals to the same radio channel unit RF1 to RF4, whereby the radio channel of the radio channel unit is always changed before transmitting a new burst, for example.

In the case shown in the figure, the coverage areas of the radio set units RF1 to RF4 are regarded as independent radio cells. Therefore one time slot of one radio channel unit is reserved from each radio set unit for sending a BCCH channel required by the GSM system. The different radio set units thus employ different frequency channels for sending the BCCH channel.

However, if the radio set units are situated at a sufficient distance from one another so that they will not disturb one another, the radio set units can send the BCCH channel on the same frequency channel.

5 The same frequency channel can be used for sending the BCCH channel also if the topography is suitable or when the radio set units are situated in different parts of the same building, whereby they will not disturb one another. One alternative for sending the BCCH channel

10 is that two radio set units, in both of which synthesizer frequency hopping is utilized, are arranged to employ the same BCCH frequency channel so that the first radio set unit uses the BCCH frequency channel only during one time slot, that is, specifically for

15 sending the BCCH channel. On the other hand, the second radio equipment utilizes all available time slots on the BCCH channel so that it uses one time slot for transmitting the BCCH channel and on others it transmits traffic channels, for example.

20 It is to be understood that the above specification and the figures related thereto are only intended to illustrate the present invention. The different variations and modifications of the invention will be evident to those skilled in the art without deviating from the scope and spirit of the invention presented in the appended claims.

25

Claims

1. A base station of a radio system comprising:

5 a central processing unit (BTS) which includes control and maintenance means (OMU) for controlling the base station in response to control signals transmitted from a base station controller (BSC), and at least one baseband frame unit (BBU1 - BBU10) for generating and supplying baseband signals further via a switching means (8) alternatively to either of at least two radio channel units (RF1 - RF4) of the base station in response to telecommunication signals transmitted from the base station controller and for processing baseband signals transmitted from said radio channel unit and for supplying them further to the base station controller (BSC), and

20 means for establishing a telecommunication connection with radio signals to radio units (MS) in the radio coverage area of the base station, characterized in that

25 the base station comprises at least two radio set units (1 - 4) arranged separately from one another of which at least one is arranged at a distance from the central processing unit, whereby said at least two radio channel units (RF1 - RF4) are arranged into different radio set units (1 - 4) for transferring baseband signals transmitted from the frame unit (BBU1 - BBU10) to a predetermined radio channel and for forwarding radio frequency signals via antenna means (ANT1) of the radio set unit (1 - 4), and for transferring radio frequency signals received with the antenna means (ANT2) to the baseband and for supplying the baseband signals to the frame unit (BBU1 - BBU10).

30 2. A base station according to claim 1,

characterized in that at least one radio set unit (1 - 4) has a data transmission connection with the central processing unit (BTS) on a data channel (5) comprised of an optical fibre, a copper wire or a micro wave link, whereby the central processing unit (BTS) and the radio set unit (1 - 4) comprise signal shaping means (BBU1 - BBU10, I/F) for shaping telecommunication signals transmitted between them into a form suitable for transmission on the data channel (5).

3. A base station according to claim 1 or 2,
characterized in that at least one radio
set unit (1 - 4) comprises several radio channel units
(RF1 - RF4) tuned into different radio channels,
whereby a specified frame unit (BBU1 - BBU10) is
arranged to supply via the switching means (8) the
signals associated with the same logical channel to
different radio channel units of the same radio set
unit (1 - 4) in accordance with a frequency hopping
sequence designated by the base station controller
(BSC).

4. A base station according to claim 1 or 2,
characterized in that the specified frame
unit (BBU1 - BBU10) is arranged to supply the signals
associated with the same logical channel repeatedly to
the same radio channel unit (RF1 - RF4) of the radio
set unit (1 - 4), and that said radio channel unit (RF1
to RF10) comprises means for changing the radio channel
to be used in accordance with a frequency hopping
sequence designated by the base station controller
(BSC).

5. A base station according to any of claims 1 to 4, characterized in that the base station is a base station of a time division cellular radio system, whereby the same frame unit (BBU1 -

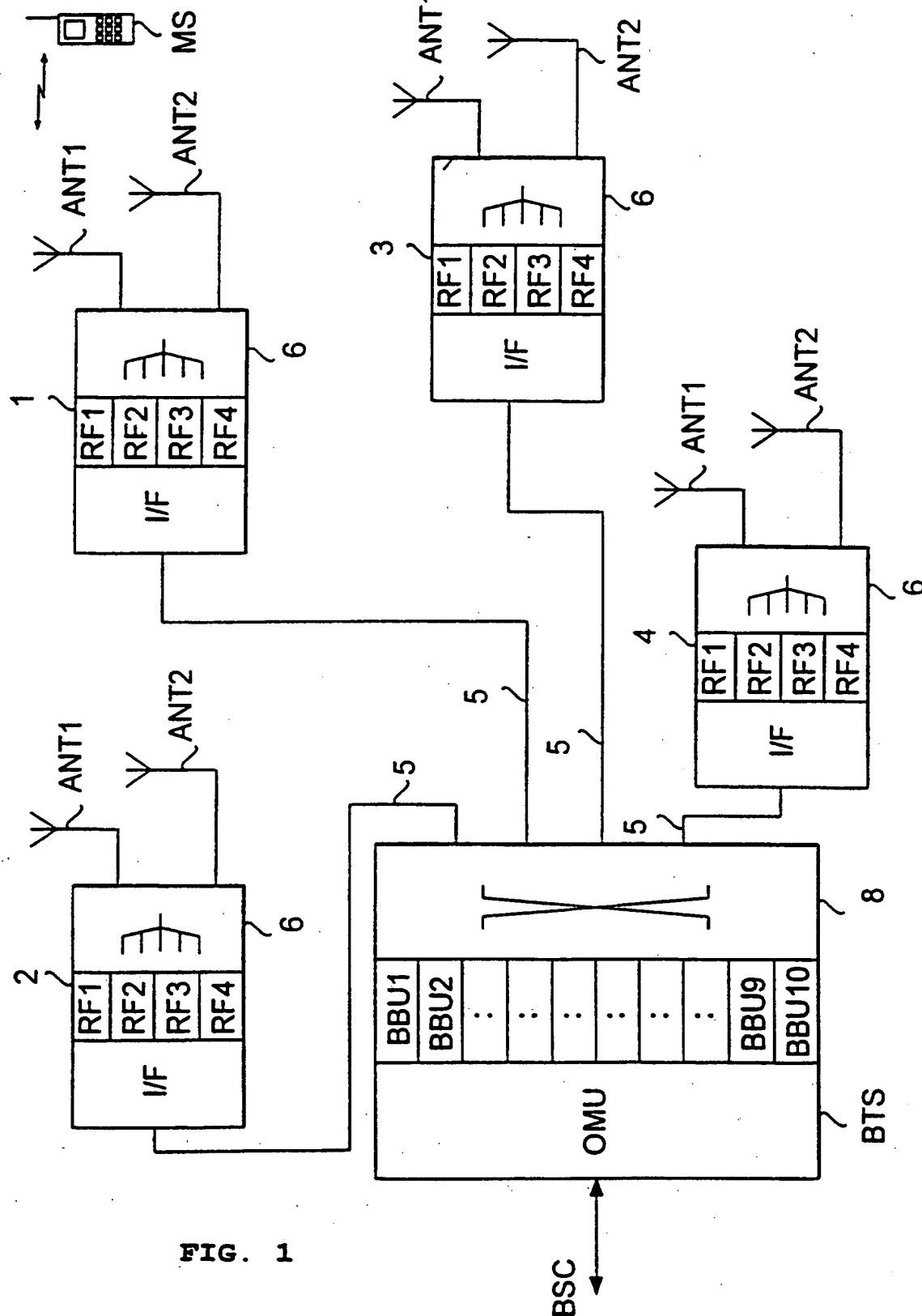
10

BBU10) is arranged to supply the signals to be transmitted in different time slots via the switching means (8) to the radio channel units (RF1 - RF4) situated in different radio set units (1 - 4).

5 6. A base station according to any of claims 1 to 5, characterized in that said base station is a base station of the GSM system.

10 7. A base station according to any of claims 1 to 6, characterized in that the distance between at least one radio set unit (1 - 4) and the central processing unit (BTS) is several kilometres.

1 / 1

**FIG. 1**

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 96/00112

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04Q 7/30, H04B 7/26

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04Q, H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0600681 A1 (AMERICAN TELEPHONE AND TELEGRAPH COMPANY), 8 June 1994 (08.06.94), see whole document	1-2
Y	--	3-7
Y	WO 9320625 A1 (TELEFONAKTIEBOLAGET LM ERICSSON), 14 October 1993 (14.10.93), page 1, line 21 - page 2, line 1; page 4, line 15 - line 32, claims 1,6 --	3-7

 Further documents are listed in the continuation of Box C. See patent family annex.

- * Special categories of cited documents
- "A" document defining the general state of the art which is not considered to be of particular relevance
- "B" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search

Date of mailing of the international search report

8 August 1996

09 -08- 1996

Name and mailing address of the ISA/
Swedish Patent Office
Box 5055, S-102 42 STOCKHOLM
Facsimile No. + 46 8 666 02 86

Authorized officer

Peter Hedman
Telephone No. + 46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 96/00112

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>EP 0439926 A2 (AMERICAN TELEPHONE AND TELEGRAPH COMPANY), 7 August 1991 (07.08.91), column 1, line 39 - column 2, line 43; column 3, line 7 - column 4, line 33; column 7, line 43 - column 9, line 43, figures 1 and 2</p> <p style="text-align: center;">--</p> <p style="text-align: center;">-----</p>	1-2,5

INTERNATIONAL SEARCH REPORT

Information on patent family members

31/07/96

International application No.

PCT/FI 96/00112

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A1- 0600681	08/06/94	NONE	
WO-A1- 9320625	14/10/93	NONE	
EP-A2- 0439926	07/08/91	SE-T3- 0439926 AU-B, B- 621011 27/02/92 AU-A- 6929691 01/08/91 CA-A- 2029615 01/08/91 DE-D, T- 69023114 18/04/96 ES-T- 2078322 16/12/95 JP-A- 7059143 03/03/95 US-A- 5084869 28/01/92	

**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- BLACK BORDERS**
- IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- FADED TEXT OR DRAWING**
- BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- SKEWED/SLANTED IMAGES**
- COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- GRAY SCALE DOCUMENTS**
- LINES OR MARKS ON ORIGINAL DOCUMENT**
- REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- OTHER:** _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.

THIS PAGE BLANK (USPTO)